

Australia Biodegradable Plastics Research

May 31, 2005

Dr. Joseph P. Greene

Department of Mechanical Engineering Mechatronic
Engineering and Manufacturing Technology
California State University, Chico

Topics

- Purpose
- University Information
- Industrial Partner
- Processing
- Testing
- Composting Testing Methods
- Conclusions
- Future Collaboration

Purpose

- Sabbatical during Spring of 2005
- University of Queensland (UQ) in Brisbane, Australia
- Swinburne University of Technology in Melbourne, Australia.
- Hosts
 - Dr. Peter Halley at UQ Brisbane, Australia
 - Dr. Greg Lonergan at the Swinburne University of Technology
- Objectives
 - Understand the dynamics of starch-based biodegradable plastics
 - Processed with conventional thermoplastic processing equipment,
 - Understand key testing characteristics of the biopolymer
 - Meet with leading researchers in the starch-based plastics area
 - Determine what testing and processing equipment are necessary for CSU, Chico to conduct research in biodegradable polymers.

University Information

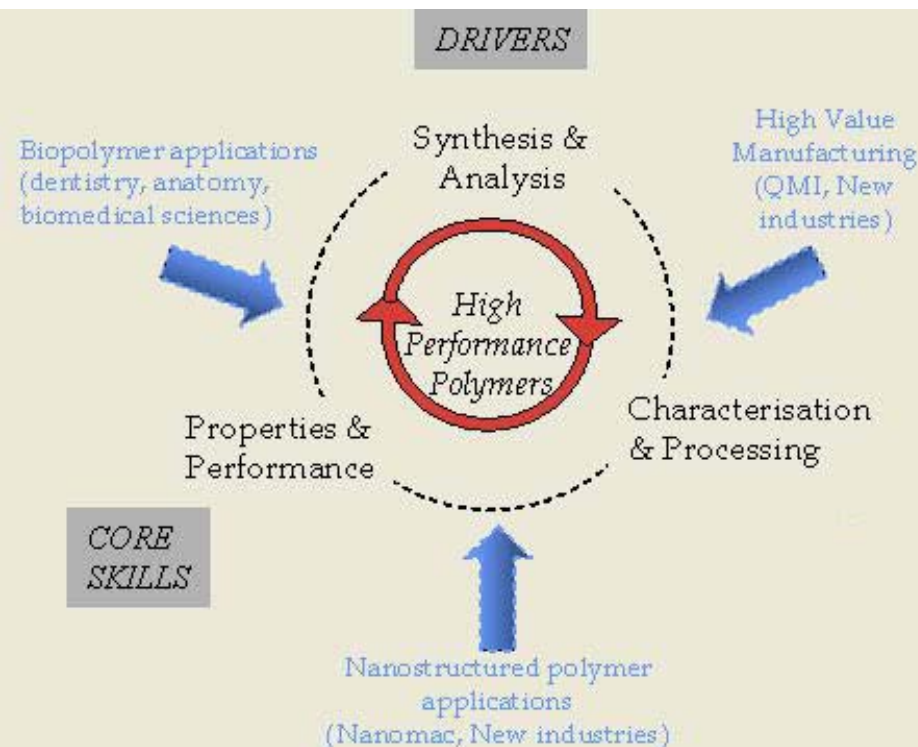
- The University of Queensland in St Lucia
 - Located approximately seven kilometers from Brisbane
- The campus is a teaching and research facility.
 - 35,000 students with many visiting foreign students
- Engineering School is located in the Engineering, Architecture, and Planning Study Area.
- Bachelor of Engineering program has twelve majors
 - Chemical, Civil, Computer Systems, Electrical, Environmental, Materials, Mechanical and Space, Mechatronic, Minerals Process, Mining, and Software.

University Information

- The Chemical Engineering field of study
 - 200 undergraduate students and 100 graduate students.
- The department has 28 fulltime faculty and research staff.
- Research in Chemical Engineering
 - Material and Chemical Product Engineering,
 - Environmental Engineering, and
 - Biological and Biomedical Engineering.
- Starch-based plastics research is part of the High Performance Polymers Processing group led by Dr. Peter Halley

University Information

- Department of Chemical Engineering
 - Center for High Performance Polymers (CHPP)
 - Biomaterials- Starch, lignin, polyurethane
 - Development of materials for packaging applications
 - Processing and properties and rheology



Industrial Partner

- Plantic Technologies Limited Melbourne, Australia
 - Develops and manufactures biodegradable materials made from renewable resources.
 - Began operations in 2002 from federal research grant with UQ
 - Produces starch-based polymer materials and thermoformed trays for Australia and Europe
 - Materials meet European Composting and Biodegradable standards.



Processing

- Thermoplastic processing
 - Injection molding on 1998 Demag Ergo Tech 75 tons
 - Egg shells for Eco Conference in Germany
 - Tensile bars for shrinkage studies
 - Extrusion with Twin screw
 - Compounding of starch with water and PVOH for molding
 - Compounding of starch with additives for barrier properties
 - Compression molding
 - For test samples that are used with DSC, optical microscopy, and other tests.

Testing

- Physical
 - Moisture %, shrinkage, moldability
- Thermal
 - Differential scanning calorimetry (DSC)
- Rheology
 - Parallel-plate viscometer from Rheometric Scientific
- Optical
 - Olympus AX70 microscope with spot digital camera
 - Crystallinity and gelatinization measurements
 - Maltese cross denotes crystallinity

Composting Testing Methods

- Swinburg University of Technology in Melbourne, Australia
 - Dr. Greg Lonergan, Composting Standards Specialist for Australia.
 - Uses European DIN standards
 - State-of-the-art facility
 - Lab Scale
 - » 24 ice-tea type glass jars as composting vessels with appropriate amounts of compost and plastics in the jar.
 - » CO₂ and CH₄ are collected and measured with a gas sensor that is based upon smoke alarm sensors.
 - » Cellulose is used as a control. The sensor is calibrated at 10% CO₂ with a gas chromatograph.
 - Pilot Scale
 - » Compost bins that are instrumented to measure CO₂ , CH₄, and the temperature and moisture of the compost.

Conclusions

- Significant amount of research occurs in Australia to find additional commercial products for starch based polymers.
 - Plantic Corporation is a 3 year-old start-up company that is looking to expand in Australia and in Europe.
- Starch-based plastics can be molded with conventional plastic molding machines with special attention paid to low melt temperatures (120°C) and high moisture and plasticizers content of 10 to 15%.
- Testing research is needed to understand the crystallization and gelatinization phenomena
- Blown film research is underway, though the extensional viscosity of the starch-based plastics is too low.
- Composting test methods are well established and accepted for starch-based plastics, and polyester based biodegradable materials.

Future Collaboration

- Dr. Halley and Dr. Lonergan are very interested in future work with CSU, Chico.
- Dr. Halley plans to visit Chico in May of 2006.
- Dr. Lonergan is very interested in the research work underway with CSU, Chico and CIWMB